Deciphering The Fluviomarine Sedimentation Record Of The Northern California Continental Shelf: A High-Resolution C-14 Geochronological Approach

W. Rockwell Geyer and Christopher K. Sommerfield
Applied Ocean Physics and Engineering
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
phone: (508) 457-2868 fax: (508) 457-2195 email: rgeyer@whoi.edu
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LONG-TERM GOALS

The overarching goal of this research is to understand the variability of sediment accumulation rates and strata formation on continental shelves as influenced by sediment supply and dispersal, hydrodynamics, and tectonics. Investigating the controls on sedimentation patterns and rates on a range of temporal and spatial scales is necessary to link short-term sedimentary processes and the stratigraphic record.

OBJECTIVES

The major objective of this research is to develop high-resolution C-14 geochronologies for piston cores collected in the STRATAFORM study area on the northern California continental shelf. C-14 ($t_{1/2}$=5730 yr) geochronology allows for determination of sediment accumulation rates averaged on time scales ranging from several hundred to many thousands of years. Because sediment accumulation rates integrate a range of environmental/tectonic conditions, they provide a means to relate transport processes and stratigraphic products. Spatial and temporal variations in sediment accumulation rates on the shelf have been interpreted in consideration of sediment-source proximity and magnitude, oceanic circulation, and deeper stratigraphy revealed by seismic reflection profiles. In addition, C-14 dates have provided necessary chronological control for determining the frequency of sedimentary event layers (produced by floods and storms) preserved in shelf deposits. The results of this research are expected to (1) generate new insights into relationships between sedimentary processes and shallow stratigraphy and (2) provide parameters (i.e. accumulation rates) necessary for numerical models of strata formation.

APPROACH

The sedimentary records of STRATAFORM piston cores collected on several across-shelf transects (60-150 m water depths) in the northern California study area are the primary focus of this research. Detailed down-core profiles of C-14 age dates, measured by Accelerator Mass Spectrometry (AMS) are generated. Age-depth modeling is used to develop sediment chronologies and determine accumulation rates for shelf sites, and additional measurements on cores (grain-size and X-radiography) are made to help with interpretation. Along-shelf and across-shelf patterns in sediment accumulation rates are interpreted in the context of the Eel River dispersal system and shelf tectonic regime using (1) published environmental data sets (e.g. sediment discharge) and (2) seismic and sediment-transport observations made by other STRATAFORM research groups.

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WORK COMPLETED

During FY98/99 a large number of piston cores (41 total) were collected on STRATAFORM cruises PS9803, W9807, and TN096 and processed subsequently for sedimentology and C-14 analysis. The coring program was designed to (1) provide full coverage of shelf sedimentary environments in the STRATAFORM study area and (2) sample specific sub-bottom stratigraphic features identified through high-resolution seismic profiling (N. Driscoll, WHOI). Approximately 50 samples of organic (plant macrofossils) and inorganic (shell) carbonaceous materials were analyzed for radiocarbon content during FY99. Early results of this work were presented at the 1998 Fall AGU Meeting in San Francisco. To date, these radiocarbon analyses have been used to develop detailed chronologies for 10 piston cores. It anticipated that another 10 chronologies will result from work during FY00.

RESULTS

C-14 chronologies developed during the past year provide new insight to the magnitude and variability of sediment accumulation rates and strata formation on the northern California shelf. Preliminary results indicate that accumulation rates on the Eel shelf are spatially variable at 1-6 mm/y, averaged over the past 2000-5000 years, and tend to be highest just north of the river mouth along the "K" transect. In the northernmost region of the Eel shelf and along the adjacent Klamath River shelf, rates are less variable at 1-2 mm/y, averaged over the past 3000-5000 years. The along-margin variation in accumulation rates may be related to hydrodynamic and/or tectonic conditions presently under investigation. At some depositional sites, C-14 based sediment accumulation rates are concordant with those previously determined by Pb-210 ($t_{1/2}$=22.3 yr) chronology (Sommerfield and Nittrouer, 1999), which averages over the past ~100 years. At other sites, Pb-210 rates are somewhat higher than C-14 rates and suggest that changes in sedimentation conditions have occurred recently. Climate-related variations in Eel River sediment influx may, in part, explain the changes in shelf accumulation rates (Sommerfield, 1998).

Interestingly, while most of the 3-4-m long piston cores bottomed out in late Holocene strata deposited between 1,500 and 5000 yrBP, erosional deposits exposed at the Eel shelf edge (150 m water depth) dated at 11,000-12,000 yrBP. A core from this area (O-150) contained flood and storm layers similar to those that form today in 50-70 m water depths and which are presently under investigation by the STRATAFORM seabed group. The C-14 ages of these older strata will provide necessary chronological control for deeper deposits underlying the Eel shelf.

IMPACT/APPLICATIONS

An understanding of the processes that influence sediment accumulation rates on continental shelves will provide insight to geologic conditions (e.g. sediment influx, hydrodynamics and tectonics) that affect stratal geometry on a range of time and length scales. This insight is necessary for developing models of strata formation for continental margins, a major goal of the STRATAFORM program.

TRANSITIONS AND RELATED PROJECTS

The results of this research are being utilized by STRATAFORM scientists investigating the formation, modification and preservation of sedimentary event layers (R. Wheatcroft, OSU; J. Borgeld, HSU; C. Nittrouer, UW), continental slope sedimentation (C. Alexander, SIO), and methods of stratigraphic modeling (D. Swift ODU). During FY00, the C-14 data will continue to be used in

concert with high-resolution seismic data generated by other STRATAFORM research groups in order to interpret the depositional history of the Eel shelf.

REFERENCES

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